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ORIGINAL ARTICLE

Surveys on the Prevalence of Pediatric Bronchial Asthma in Japan: A Comparison between the 1982, 1992, and 2002 Surveys Conducted in the Same Region Using the Same Methodology

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ABSTRACT

Background: We conducted and reported the first (1982; 55,388 subjects), and second (1992; 45,674 subjects), epidemiological surveys conducted on bronchial asthma in elementary students across 11 prefectures in western Japan. The 2 surveys were conducted in the same regions using the same methodology employing a modified Japanese version of the American Thoracic Society-Division of Lung Diseases (ATS-DLD) Epidemiology Questionnaire. We conducted the third survey in 2002, and compared the findings to those of previous studies.

Methods: In the third survey, 37,036 students attending the same schools as in previous surveys (in 11 prefectures) were given the questionnaire. A total of 35,582 responses (96.1%) were collected. An ATS-DLD Epidemiology Questionnaire was also used in this study, and the findings were compared to those of previous studies.

Results: 1. The prevalence of bronchial asthma (BA) in boys, girls, and all students was 3.8%, 2.5%, and 3.2%, respectively, for the first survey; 5.6%, 3.5%, and 4.6% for the second survey; and 8.1%, 4.9%, and 6.5% for the third survey.

2. A decline in the BA prevalence in older subjects which could be seen in the first survey was absent in the second and third surveys. There were no regional differences in the third survey.

3. The boys-to-girls ratio in the first, second, and third surveys was 1.5, 1.6, and 1.6, respectively.

4. BA was more prevalent among subjects with a past history of respiratory disease in infancy and those with a family history of allergic disease.

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5. The prevalence of asthma symptoms and wheezing in the first, second, and third surveys was 7.1%, 9.8%, and 11.8%, respectively.

6. A comparison of the prevalence of other allergic diseases between the second and third surveys revealed a decrease in atopic dermatitis and an increase in allergic rhinitis, allergic conjunctivitis, and cedar pollinosis.

Conclusions: BA prevalence in the third survey increased 2.1 and 1.4 times respectively compared to the first survey and second survey, indicating an upward trend in all regions and age groups surveyed.

KEY WORDS

allergic diseases, bronchial asthma, epidemiology, prevalence of asthma, wheezing

ABBREVIATIONS

ATS-DLD, American Thoracic Society-Division of Lung Diseases; BA, Bronchial asthma; W, Wheezing; AR, Allergic rhinitis; AD, Atopic dermatitis; AC, Allergic conjunctivitis; Pjc, Pollinosis of Japanese cedar; SPM, Suspended particulate matter.

INTRODUCTION

Japan is experiencing an increase in the number of children with bronchial asthma and other allergic diseases. We conducted the first epidemiological survey in 1982 in 55,388 students at 70 elementary schools across 11 prefectures in western Japan using a Japanese modified version of the American Thoracic Society-Division of Lung Diseases (ATS-DLD) Epidemiology Questionnaire.[1] The survey revealed the following: (1) The prevalence of bronchial asthma (BA) declined as the school grade progressed, with 3.8% for boys, 2.5% for girls, and 3.2% overall. The prevalence in students in the sixth grade was three-fourths of that of students in the first grade; (2) BA prevalence was 1.5 times more common in urban areas than in rural areas; (3) No relationship between the prevalence of asthma and smoking or heating could be identified; (4) The prevalence of BA in students having had a family member with a history of major allergy within the second degree was 2.4 times higher than in students with no such family history, and the prevalence of BA in subjects having had a family history of BA was 3.8 times higher than in those with no family history of the condition; (5) Wheezing (W) occurred in 4.2% of boys, 3.6% of girls, and 3.9% overall, and the prevalence of W in students in the sixth grade was 50% of those in the first grade; (6) The rate of BA remission rose as the school grade went higher, with 1.3% for boys, 0.7% for girls, and 1.0% overall.

The second survey was conducted in 1992 in 45,674 students attending the same schools in the same regions in the same manner.[2] The findings were as follows: (1) The prevalence of BA was 1.4 times higher than the observation 10 years before, with 5.6% for boys, 3.5% for girls, and 4.6% overall, showing a consistent increase in all regions and grades surveyed; (2) No significant differences in BA prevalence could be found among grades. The boys-to-girls ratio was 1.6 : 1, and differences between regions were smaller compared to those identified in the first survey; (3) Subjects who had experienced a respiratory disease in early childhood, or had a family history of allergic diseases, or lived in urban areas were more likely to suffer from BA, and 13.3% of those with a family history of BA living in urban areas had BA; and (4) The W prevalence was 5.2%, which was 1.3 times higher than the rate 10 years ago, showing an increase in all regions. The rate showed a decrease as the school grade progressed.

We conducted the third survey in 2002 in 35,582 students attending the same schools in the same regions using the same method and definition in order to determine the prevalence of BA, W, and other allergic diseases, including BA remission, and then compared the results with those of the first and second surveys.

METHODS

In the third survey, 37,036 students attending the same schools as in previous surveys in 11 prefectures, including all prefectures in Kyushu, Yamaguchi, Hyogo, and Kagawa prefectures, were given the questionnaire. A total of 35,582 responses (96.1%) were collected. Table 1 shows the number of subjects by prefecture and gender.

A modified Japanese version of the ATS-DLD questionnaire was used in all 3 surveys.[3] The definition for diseases were consistent across all surveys, and those who met all of the following 6 criteria were regarded as having BA Subjects who met the following criteria (1)–(5) but did not meet criterion (6) were regarded as BA remission: (1) have experienced an attack of wheezing and/or shortness of breath; (2) have had 2 or more attacks in the past; (3) have been told by your doctor that you have BA, asthmatic, or pediatric asthma; (4) wheezing could be heard during an attack; (5) experienced shortness of breath and wheezing during an attack; and (6) have experienced such an attack (or symptoms) or have received treatment for BA, asthmatic bronchitis, or pediatric

Table 1 Subjects of three surveys (1982,1992, 2002)

Prefecture	No.of Schools	Subjects								
		Male			Female			Total		
		1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Fukuoka	19	4905	4575	3421	4827	4394	3296	9732	8969	6717
Saga	11	3404	2984	2355	3198	2989	2392	6602	5973	4747
Nagasaki	13	5040	4074	3422	4983	3987	3384	10023	8061	6806
Kumamoto	8	2915	2526	1948	2809	2301	1895	5724	4827	3843
Kagoshima	8	3087	2297	1423	2910	2441	1423	5997	4738	2846
Ooita	4	1666	1125	1217	1680	1169	1176	3346	2294	2393
Miyazaki	2	925	847	565	961	863	533	1886	1710	1098
Yamaguchi	6	2624	1893	1327	2592	1831	1336	5216	3724	2663
Okinawa	4	1225	1018	853	1255	1011	848	2480	2029	1701
Hyougo	2	577	366	426	573	344	385	1150	710	811
Kagawa	3	1668	1347	994	1564	1292	963	3232	2639	1957
Total	80	28036	23052	17951	27352	22622	17631	55388	45674	35582

Age: 6－12 years.

The rate of urban, middle and rural area is 23.4%, 61.0%, 15.7% (1982), 21.6%, 58.1%, 20.3% (1992) and 13.1%, 77.1%, 9.8% (2002), respectively.

asthma in the past 2 years.

Those who met the following 3 criteria but did not meet the criteria for BA and BA remission were regarded as having W: (1) occasional wheezing; (2) wheezing symptoms occurred in conjunction with a cold; and(3) wheezing experienced twice or more in the past 2 years.

In the second and third surveys, the prevalences of other allergic diseases were also investigated in addition to BA and W. The criteria for those diseases in the questionnaire were as described below.

Allergic rhinitis (AR): subjects responded positively to the questions "Have you ever been diagnosed with AR or pollinosis-related rhinitis?" and to either of the questions "Do you still have rhinitis symptoms (e.g., sneezing, runny or blocked nose)?" or "Do those symptoms sometimes worsen, particularly from February to April?"

Atopic dermatitis (AD): subjects responded positively to both questions "Have you ever been given a diagnosis of eczema or AD?" and "Do you still have such symptoms?"

Allergic conjunctivitis (AC): subjects responded positively to the questions "Have you ever been given a diagnosis of AC or pollinosis-related conjunctivitis?" and to either of the questions "Do you still have conjunctivitis symptoms (e.g., itchy eyes, red eyes, excessive tearing)?" or "Do those symptoms worsen from February to April?"

Pollinosis of Japanese cedar (Pjc): subjects responded positively to questions (1) and (2), or to all questions from (3) to (6). (1) Have you ever been diagnosed with pollinosis? (2) Do your symptoms of pollinosis (e.g., nose, eyes, systemic symptoms) worsen, particularly from February to April? (3) Have you ever been diagnosed with AR or pollinosis-related rhinitis? (4) Do your rhinitis symptoms worsen from February to April? (5) Have you ever been diagnosed with AC or pollinosis-related conjunctivitis? (6) Do your conjunctivitis symptoms worsen from February to April?

Regarding other allergic diseases: subjects responded positively to any one of the above questions for BA, W, AR, AD, AC, and Pjc.

Regions were classified into urban, rural, or urban/rural areas according to the following definitions: an urban area is where the life style is generally urbanized and public transportation is substantially developed; a rural area is where the old life style still remains to some extent and traffic is relatively light; and an urban/rural area can be categorized as being between urban and rural areas.

The distribution of students in urban, rural, and urban/rural areas are shown below in Table 1. The third survey revealed that the largest distribution of students was in the urban/rural area and that the distribution in rural areas had decreased.

Domestic heating was classified into 2 types, the Clean type, consisting of no heating, electric stoves, electric *kotatsu*, a clean (forced-ventilation) heating system (kerosene or gas), a stove with a chimney (kerosene, gas, coke briquette); and the Dirty type, consisting of a stove without a chimney (kerosene, gas, etc.), and a charcoal or briquette brazier or *kotatsu*.

The relationship between the prevalence rates of asthma in each school and the concentration of NOx or SPM was examined. The value of NOx and SPM

was measured by the National Institute for Environmental Studies at 27 air quality monitoring stations within 2 km from each elementary school.

STATISTICAL ANALYSES

Fisher's exact test and the Cochran-Armitage trend test were used to determine inter-category differences and to evaluate upward or downward trends, respectively. A simple regression analysis and Pearson's product-moment correlation coefficient were used to evaluate two paired continuous variates, while Spearman's rank-order correlation coefficient was used for two paired ordinal variates.

Potential factors affecting the incidence of allergic diseases were classified into host factors or environmental factors. Each of these factors were evaluated using a logistic regression analysis using the data obtained from the third survey to identify risk factors.

Statistical analyses were performed using the SAS Procedure (CORR, FREQ, LOGISTIC).

RESULTS

1. PREVALENCE OF BRONCHIAL ASTHMA

The prevalence of BA from the first survey → second survey → third survey was 3.8% → 5.6% → 8.1% for boys, 2.5% → 3.5% → 4.9% for girls, and 3.2% → 4.6% → 6.5% overall, indicating a significant increase in all populations ($p < 0.001$). The changes in prevalence which can be observed over time according to grade and gender are shown in Table 2 and Figure 1. A significantly lower rate in prevalence in students in higher grades could be observed in the first survey ($p < 0.05$). However, this could not be identified in either the second ($p = 0.3450$) or third ($p = 0.6547$) surveys. The prevalence rate increased by 140% in the second survey in comparison to the first survey, and by 140% in the third survey in comparison to the second survey, and by 210% in the third survey in comparison to the first survey. The rate also increased in all prefectures surveyed. When the rate of increase over the 20 year period was compared among prefectures, the highest and lowest increase rates were 340% and 160%, respectively. The difference between the highest and the lowest prevalence rates of each prefecture was within 200% in all surveys.

In the first and second surveys, BA was most prevalent in urban areas, followed by urban/rural areas, and then rural areas ($p < 0.001$), while the third survey revealed no difference according to type of area ($p = 0.5500$) (Table 3).

BA prevalence according to population density in each survey was as follows: in the first survey, 4.0% ($n = 20,421$) for regions of $\geq$ 1,500 people/km^2, 2.8% ($n = 31,545$) for regions of 250–1,500 people/km^2, and 1.8% ($n = 3,422$) for regions of <250 people/km^2 (tendency $p < 0.001$); in the second survey, 5.2% ($n = 14,361$), 4.3% ($n = 29,200$), and 4.0% ($n = 2,113$) (trend $p < 0.001$); and in the third survey, 6.5% ($n = 11,994$), 6.5% ($n = 22,060$), and 6.3% ($n = 1,528$) (trend $p = 0.8405$), respectively, showing no difference in BA prevalence according to population density in the third survey.

An analysis of relationships between the prevalence rate and air pollutants (NOx, SO_2, and suspended particulate matter (SPM)) disclosed that the relationship with SPM in the second survey was significant. In that survey, higher concentrations of SPM were associated with a higher prevalence rate of BA ($Y = 0.0632X + 2.4502$, $r = 0.50$).

The proportion of subjects with family members who smoked indoors in the first, second, and third surveys was 65.3%, 55.4%, and 53.0%, respectively. No significant difference between the indoor smoking group and the nonsmoking group could be seen. The number of cigarettes smoked was not associated with BA prevalence (Table 4). While the first survey demonstrated a higher prevalence of BA in the clean-type heating group ($p < 0.01$), the dirty-type heating group had a higher prevalence in the second and third surveys ($p < 0.01$ and $p < 0.05$, respectively) (Table 4). No statistically significant differences in the difference cooling systems were observed in the prevalence rate. When BA prevalence was analyzed according to type of feeding in infancy, 4.5% of non-breast-fed subjects, 4.4% of mixed-fed subjects, and 4.8% of breast-fed subjects had BA in the second survey, indicating no specific trend ($p = 0.1317$) . In the third survey, BA prevalence was 5.8%, 6.4%, and 6.9%, respectively, indicating a significant upward trend from non-breast feeding to breast feeding ($p < 0.001$) (Table 4).

The BA prevalence in subjects in the first, second, and third surveys who had experienced a severe cold or a major respiratory disease by the age of 2 was 11.6%, 12.2%, and 16.3%, respectively. The prevalence in those without such experiences in earlier childhood was 2.4%, 3.7%, and 4.8%, respectively. A large difference could be observed across the 3 surveys between the 2 populations ($p < 0.001$).

The BA prevalence in subjects with a past history of asthmatic bronchitis in the first, second, and third surveys was 34.0%, 34.0%, and 35.8%, respectively, whereas in those without a history of the disorder, the prevalence was 0.6%, 0.9%, and 1.4%, respectively, indicating a higher prevalence in the population possessing such a history ($p < 0.001$) . In the first survey, 81.3% of subjects with BA had a history of asthmatic bronchitis, while in the second and third surveys, the number was 83.0% and 81.3%, respectively. A history of asthmatic bronchitis was identified in 3.3% of subjects (controls) without BA, W, or BA remission in the first survey, 4.5% in the second survey, 6.3% in the third survey. The prevalence of a history of pneumonia and bronchitis in BA subjects was 9.7%, 9.6%, and 12.7%, respectively, in the first, second, and third surveys (2.1%, 2.2%, and 3.2%, respectively, for the con-

Table 2 Prevalence rate of asthma and wheeze in school grade and sex

(%)

	School Grade	Male			Female			Total		
		1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Bronchial asthma	1	4.38	5.69	7.62	2.65	3.44	4.83	3.53	4.56	6.26
	2	3.70	6.32	7.88	2.62	3.07	5.08	3.17	4.70	6.47
	3	4.13	4.89	8.49	2.56	3.44	5.02	3.35	4.17	6.76
	4	3.58	5.14	7.45	2.27	3.46	5.58	2.92	4.32	6.52
	5	3.79	5.81	8.82	2.58	4.02	4.11	3.19	4.93	6.46
	6	3.37	5.81	8.21	2.27	3.72	4.85	2.82	4.78	6.55
	Total	3.83	5.61	8.07	2.49	3.53	4.91	3.17	4.58	6.51
	P-value[a)]	0.0259	0.8318	0.2588	0.2369	0.0906	0.4963	0.0107	0.3450	0.6547
	P-value[b)]		< 0.001			< 0.001			< 0.001	
	School Grade	Male			Female			Total		
		1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Wheeze	1	5.75	7.23	7.65	4.47	5.78	6.42	5.13	6.50	7.05
	2	5.48	6.72	7.33	3.82	5.08	5.66	4.67	5.90	6.49
	3	4.05	5.75	5.94	4.17	4.56	5.12	4.11	5.16	5.53
	4	3.84	5.82	4.74	3.20	4.72	4.10	3.52	5.28	4.42
	5	2.92	5.08	4.51	3.29	3.83	3.80	3.10	4.47	4.15
	6	2.69	4.82	4.81	2.67	3.59	3.74	2.68	4.22	4.29
	Total	4.17	5.88	5.83	3.62	4.58	4.80	3.90	5.24	5.32
	P-value[a)]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	P-value[b)]		< 0.001			< 0.001			< 0.001	
	School Grade	Male			Female			Total		
		1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Bronchial asthma + Wheeze	1	10.13	12.91	15.27	7.12	9.22	11.25	8.66	11.06	13.31
	2	9.18	13.04	15.20	6.44	8.15	10.73	7.84	10.60	12.97
	3	8.18	10.64	14.44	6.73	8.00	10.14	7.46	9.33	12.30
	4	7.42	10.96	12.19	5.47	8.19	9.68	6.44	9.60	10.94
	5	6.71	10.89	13.33	5.89	7.85	7.90	6.31	9.39	10.62
	6	6.06	10.63	13.02	4.92	7.32	8.59	5.49	9.00	10.84
	Total	8.00	11.49	13.90	6.11	8.11	9.71	7.07	9.82	11.82
	P-value[a)]	< 0.001	< 0.001	0.0003	< 0.001	0.0057	< 0.001	< 0.001	< 0.001	< 0.001
	P-value[b)]		< 0.001			< 0.001			< 0.001	

a) : Cochran-Armitage trend test by school grade.

b) : Cochran-Armitage trend test by time about Total.

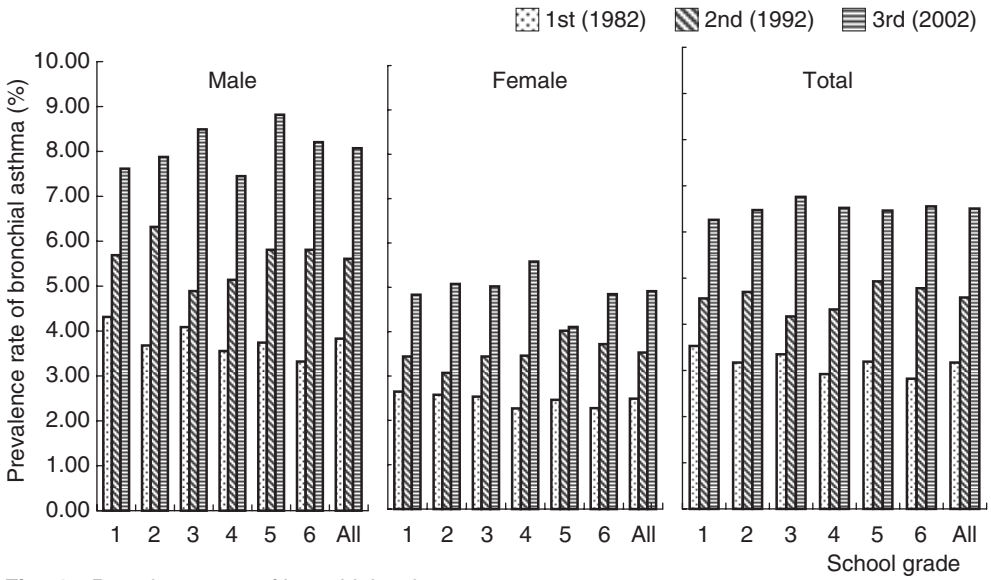

Fig. 1 Prevalence rate of bronchial asthma.

Table 3 Prevalence rate of bronchial asthma and wheeze in three areas

(%)

Area	Bronchial asthma				Wheeze				Bronchial asthma + Wheeze			
	1st	2nd	3rd	*P*-value[a)]	1st	2nd	3rd	*P*-value[a)]	1st	2nd	3rd	*P*-value[a)]
Urban	3.82	5.44	6.53	< 0.001	4.43	5.34	5.42	0.0017	8.26	10.78	11.95	< 0.001
Middle	3.08	4.48	6.55	< 0.001	3.81	5.31	5.42	< 0.001	6.89	9.79	11.96	< 0.001
Rural	2.56	3.93	6.16	< 0.001	3.43	4.94	4.41	< 0.001	5.99	8.87	10.58	< 0.001
P-value[b)]	< 0.001	< 0.001	0.5500		< 0.001	0.2098	0.0738		< 0.001	< 0.001	0.0894	

[a)] : Cochran-Armitage trend test by time.

[b)] : Cochran-Armitage trend test by area.

trol group), while BA subjects with a history of pneumonia and/or bronchitis was 43.3%, 46.6%, and 48.6%, respectively (13.2%, 16.7%, and 20.4%, respectively, for the control group). The prevalence of a history of whooping cough in BA subjects was 5.7%, 3.8%, and 2.4%, respectively (3.7%, 2.7%, and 1.4%, respectively, for the control group).

The prevalence of subjects with family members within the second degree who had a history of major allergies in the first, second, and third surveys was 41.6%, 57.6%, and 65.7%, respectively. The BA prevalence in the first, second, and third surveys was 4.9%, 6.2%, and 8.4%, respectively, for the major allergy family history (+) group, and 1.9%, 2.3%, and 2.9%, respectively, for the major allergy family history (–) group. The prevalence of subjects with a second degree family member who had a history of BA in the first, second, and third surveys was 10.7%, 16.3%, and 24.2%, respectively. The BA prevalence in the first, second, and third surveys was 9.1%, 11.9%, and 14.2% for BA family history (+) group, and 2.5%, 3.2%, and 4.1%, respectively, for the BA family history (–) group. When BA prevalence was compared between groups with and without a family history of eczema, urticaria, or AR (+) groups consistently had a significantly higher prevalence of BA compared with (–) groups ($p < 0.001$) (Table 5).

Figure 2 illustrates the relationship of the prevalence of allergic diseases to family history (father or mother, or both) of allergic diseases. As shown in the figure, subjects with BA parent(s) had a significantly higher risk of developing BA, and this tendency could also be observed in AR and AD ($p < 0.001$).

When the frequency of complications was compared with other individual allergic diseases, AR was the most frequent complication followed by AD, AC, and Pjc in the second and third surveys. In the second and third surveys, 71.7% and 68.2%, of BA subjects, respectively, experienced complications with at least one allergic disease. In the second and third surveys, 9.8% and 7.7%, of BA subjects, respectively, experienced complications with all of AR, AD, and AC,

Table 4 Relationship of prevalence rate of allergic diseases with indoor smoking and type of air conditioner

(%)

		Bronchial asthma (BA)			Allergic rhinitis (AR)		Atopic dermatitis (AD)		Allergic conjunctivitis (AC)		Pollinosis (Pjc)		Any allergic diseases	
		1st	2nd	3rd	2nd	3rd	2nd	3rd	2nd	3rd	2nd	3rd	2nd	3rd
Total		3.17	4.58	6.51	16.03	20.50	17.46	13.87	6.81	9.84	3.68	5.78	31.58	34.17
	P-value		< 0.001[c]		< 0.001[b]		< 0.001[b]		< 0.001[b]		< 0.001[b]		< 0.001[b]	
Nutritious food	mother's milk	—	4.83	6.94	15.95	21.33	18.45	14.67	6.98	10.36	3.71	6.05	32.52	35.55
	mixed	—	4.44	6.37	16.46	20.59	17.08	13.36	6.88	9.87	3.77	5.90	31.54	33.78
	artificial	—	4.51	5.75	16.16	18.61	16.81	13.31	6.69	8.57	3.62	4.81	31.09	32.20
	P-value[a]	—	0.1317	0.0015	0.4622	< 0.001	< 0.001	0.0015	0.4009	< 0.001	0.7903	0.0032	0.0099	< 0.001
Respiratory disease	with	11.63	12.15	16.32	23.43	27.29	23.76	18.59	12.19	14.32	6.29	8.08	44.30	45.78
	without	2.42	3.65	4.75	15.13	19.30	16.73	13.06	6.17	9.05	3.37	5.38	30.07	32.13
	P-value[b]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Asthmatic bronchitis	with	34.02	34.02	35.76	41.07	42.29	33.88	25.09	18.33	20.00	9.22	11.00	70.41	68.50
	without	0.64	0.87	1.42	12.87	16.72	15.39	11.93	5.36	8.08	2.99	4.87	26.69	28.21
	P-value[b]	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Number of smoked tobacco	0/day	3.05	4.64	6.44	16.92	21.95	17.53	14.26	7.41	11.16	3.95	6.58	32.35	35.79
	1－30/day	3.24	4.61	6.51	15.33	19.35	17.42	13.56	6.44	8.74	3.44	5.04	31.08	32.87
	31－/day	3.19	3.47	7.10	14.88	17.98	16.97	13.26	4.74	8.03	3.80	5.29	29.26	31.41
	P-value[a]	0.3688	0.1894	0.4537	< 0.001	< 0.001	0.5843	0.0422	< 0.001	< 0.001	0.0234	< 0.001	< 0.001	< 0.001
Heater	Clean	3.20	4.34	6.28	14.91	19.72	16.79	13.70	6.40	9.47	3.23	5.44	30.07	33.22
	Dirty	1.89	4.91	6.92	16.62	21.93	18.62	14.20	7.06	10.52	3.78	6.38	33.14	35.91
	P-value[b]	0.0036	0.0069	0.0181	< 0.001	< 0.001	< 0.001	0.1868	0.0094	0.0014	0.0026	0.0003	< 0.001	< 0.001
Cooler	Not use	—	4.45	6.11	14.55	18.20	16.28	12.13	6.69	7.96	3.51	4.62	29.51	30.25
	Use	—	4.64	6.51	16.10	20.82	18.19	13.96	6.77	10.05	3.50	5.86	32.27	34.49
	P-value[b]	—	0.4299	0.4337	0.0005	0.0019	< 0.001	0.0114	0.6760	0.0008	0.9904	0.0111	< 0.001	< 0.001

[a] : Cochran-Armitage trend test by category.

[b] : Fisher's exact test.

[c] : Cochran-Armitage trend test by time.

while 23.9% and 19.1%, respectively, had complications with both AR and AD (Table 6).

An analysis of the relationship between family history, region, and gender, revealed that the BA prevalence was the highest (15.8% and 16.2%, respectively) in boys with a family history of BA, and living in urban areas in the second and third survey, whereas the lowest BA prevalence (1.5% and 1.8%, respectively) was observed in girls without a family history of major allergies living in urban/rural areas.

As shown in Figure 3, the age of initial onset of BA showed a tendency to be lower as surveys proceeded, as the proportion of BA subjects who experienced the first onset of BA under the age of 2 was 15.0%, 16.1%, and 23.1%, respectively, in the first, second, and third surveys (tendency $p < 0.001$). Likewise, BA subjects who experienced their initial onset under the age of 6 was 79.5%, 82.0%, and 84.9%, respectively. Students in the sixth grade who had an initial onset of BA under the age of 6 accounted for 33%, 27%, and 27%, respectively.

Analyses revealed that 16.4%, 10.9%, and 7.8%, respectively, of BA subjects in the first, second, third surveys had not received any treatment, although they had experienced BA attack(s) within 2 years, while 6.9%, 9.5%, and 12.4%, respectively, of BA subjects were treated for BA, although they had not experienced releted symptoms for 2 years.

We used a logistic regression analysis to identify risk factors for BA in the third survey on subjects without a past or present history of major allergic diseases (BA, AR, AD, and AC) as controls (Table 7). Host factors evaluated in the analysis included gender, respiratory diseases under the age of 2, past history (sinusitis, bronchitis, asthmatic bronchitis, pneumonia, pertussis, eczema, otitis media, and tonsillitis), and family history (father or mother, or both) (BA, eczema, urticaria, and AR). Subjects with all host factors were included in the data. Environmental factors included the following: nutrition: breast feeding, mixed feeding, or non-breast feeding; number of siblings: 1, 2, 3, 4, or ≥ 5; paternal or maternal smoking: 0, 1–30, or ≥ 31 cigarettes/day; heating: clean-type or dirty-type; use of ventilation: yes, occasionally, no; number of rooms in the house: ≤ 3, ≤ 6, or ≥ 7 rooms; equipped or not with cooling/heating system; floor status: wooden floor or *tatami* mat; carpeting: carpeted or uncarpeted; pets (dogs, cats, birds, hamsters): have pets indoors, have pets outdoors, or have no pets; air pollutants—pollen counts: < 2000, < 3000, or ≥ 3000 cm^3; SO_2: 1–7 ppb, NOx: < 20, < 30, or ≥ 30 ppb; SPM: < 25, < 30, ≥ 30 $\mu g/m^3$, and population density: < 500, < 1500, or ≥ 1500 people/km^2. Subjects who could meet all environmental factors were included in the data.

When host factors were evaluated to identify risk factors, the odds ratio (OR) of girls was found to be extremely low (OR = 0.640) and the OR of a past history of asthmatic bronchitis was extremely high (OR = 37.633). The OR of a past history of respiratory disease (under the age of two) (OR = 1.203), sinusitis (OR = 1.487), bronchitis (OR = 1.648), or eczema (OR = 2.542) was significantly higher; whereas the OR of a past history of otitis media (OR = 0.799) was lower. A family history (father or mother, or both) with eczema (OR = 1.595) or AR (OR = 1.457) was associated with a higher prevalence of BA; a family history of BA (father or mother, or both) in particular was associated with a higher OR (OR = 2.085).

Evaluation of environmental factors using logistic regression analysis identified non-breast feeding (OR = 1.115) and dirty-type heating (OR = 1.261) as risk factors for a higher BA prevalence. On the other hand, factors associated with a low OR included the number of rooms (OR = 0.876), carpeting (OR = 0.720), and pets such as dogs (OR = 0.818) and hamsters (OR = 0.858).

2. PREVALENCE OF WHEEZING

As summarized in Table 2, the prevalence of wheezing (W) according to school grade from the first survey → second survey → third survey was 4.2% → 5.9% → 5.8% for boys, 3.6% → 4.6% → 4.8% for girls, and 3.9% → 5.2% → 5.3% overall. The W prevalence in all subjects increased by 130% in the second survey and by 140% in the third survey compared with the first survey. The W prevalence was higher in students in the lower grades and lower in students in the higher grades in all three surveys ($p < 0.001$), and the W prevalence in students in the sixth grade in the first, second, and third surveys was 52%, 65%, and 61%, of those in first grade respectively.

Logistic regression analyses of environmental factors demonstrated that breast feeding (OR = 1.087), maternal smoking (OR = 1.261), and *tatami* mat (OR = 1.118) increased the W prevalence in the third survey.

The prevalence of broadly defined bronchial asthma (BA + W) according to school grade from the first survey → second survey → third survey was 8.0% → 11.5% → 13.9% for boys, 6.1% → 8.1% → 9.7% for girls, and 7.1% → 9.8% → 11.8 % overall. The W prevalence was higher in students in the lower grades and lower in students in the higher grades in all 3 surveys ($p < 0.01$), and the W prevalence in students in the sixth grade in the first, second, and third surveys was 63%, 81%, and 81%, of those in the first grade respectively. The W prevalence increased by 130% each of the second and third surveys compared with the first survey.

3. PREVALENCE OF OTHER ALLERGIC DISEASES

The second and third surveys also investigated the prevalence of other allergic diseases. The findings are summarized as follows (Fig. 4):

Table 5 Prevalence rate of allergic diseases by family history of allergic diseases

(%)

Family History		Bronchial asthma (BA)			Allergic rhinitis (AR)		Atopic dermatitis (AD)		Allergic conjunctivitis (AC)		Pollinosis (Pjc)		Any allergic diseases	
		1st	2nd	3rd	2nd	3rd	2nd	3rd	2nd	3rd	2nd	3rd	2nd	3rd
Major allergy	+	4.89	6.24	8.35	20.50	25.55	22.63	17.38	8.79	12.18	4.93	7.36	39.57	41.60
	−	1.92	2.25	2.88	9.72	10.57	10.30	7.11	4.04	5.20	1.95	2.74	20.40	19.69
P-value *		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Bronchial asthma	+	9.12	11.91	14.18	22.39	26.97	24.56	18.55	10.63	13.28	5.30	7.55	43.26	44.94
	−	2.46	3.15	4.06	14.79	18.44	16.07	12.38	6.06	8.74	3.37	5.21	29.30	30.74
P-value *		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Eczema	+	5.38	6.80	10.17	20.90	26.65	28.70	26.28	9.28	13.82	4.96	7.83	43.39	47.39
	−	2.88	3.75	5.21	14.21	18.32	13.26	9.47	5.89	8.43	3.20	5.05	27.17	29.48
P-value *		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Urticaria	+	4.30	7.16	9.20	20.53	26.78	24.70	20.59	10.25	14.40	5.25	7.93	41.02	45.02
	−	2.88	3.99	5.78	15.00	18.81	15.80	12.07	6.03	8.61	3.33	5.19	29.43	31.25
P-value *		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Allergic rhinitis	+	5.95	6.86	8.77	25.45	30.40	23.30	17.67	10.85	14.15	6.46	9.11	43.42	45.44
	−	2.63	3.43	4.63	11.30	12.29	14.52	10.73	4.78	6.26	2.29	3.01	25.63	24.82
P-value *		< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

* : Fisher's exact test.

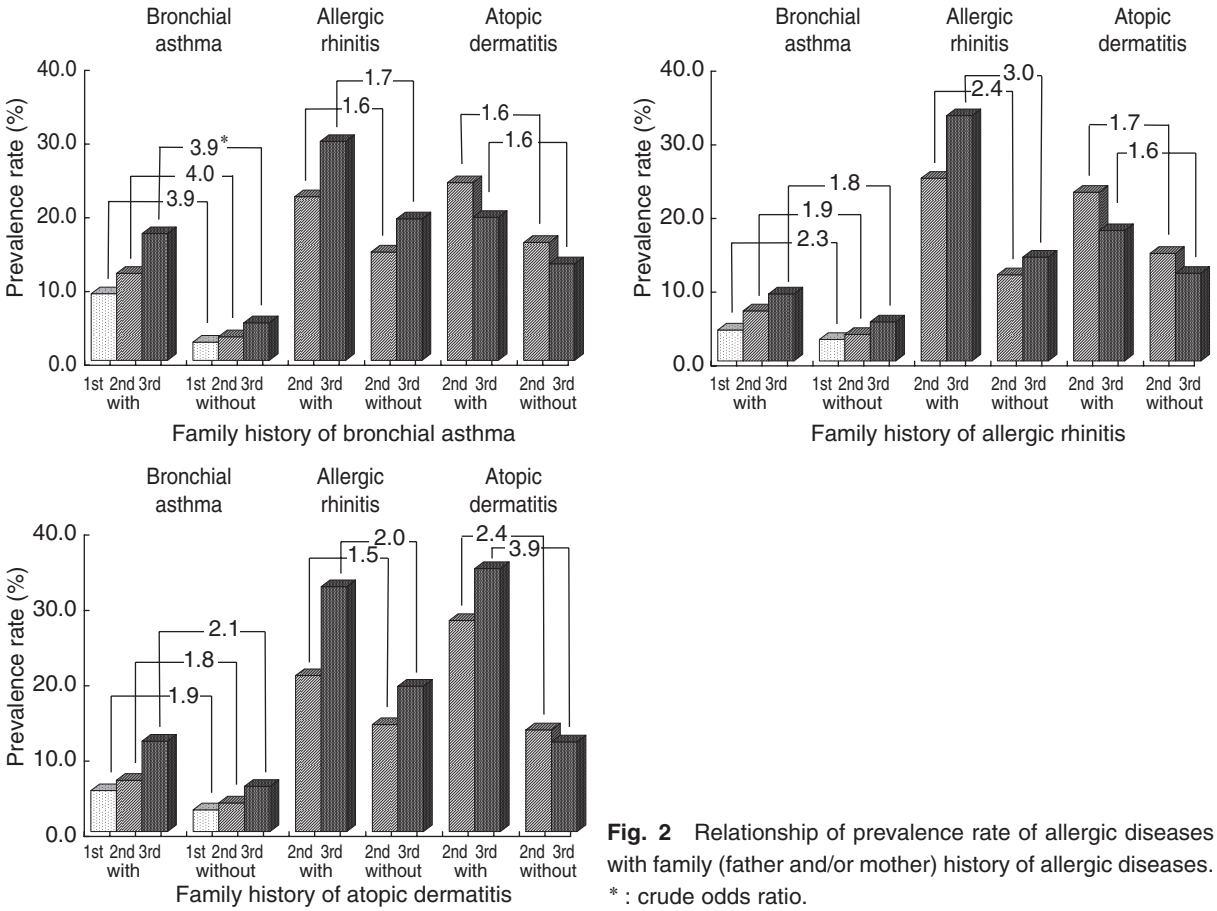

Fig. 2 Relationship of prevalence rate of allergic diseases with family (father and/or mother) history of allergic diseases.
* : crude odds ratio.

Table 6 Complication rate of other allergic diseases in bronchial asthmatic children

(%)

Complication	2nd	3rd
Allergic rhinitis (AR)	53.0	52.8
Atopic dermatitis (AD)	39.7	31.1
Allergic conjunctivitis (AC)	24.0	24.7
Pollinosis (Pjc)	12.1	12.6
AR + AD	23.9	19.1
AR + AD + AC	9.8	7.7
Any allergic diseases	71.7	68.2

1) The prevalence rate observed from the second to third surveys was 16.0% → 20.5% for AR, 17.5% → 13.9% for AD, 6.8% → 9.8% for AC, and 3.7% → 5.8% for Pjc. In the third survey, AD decreased ($p < 0.001$), however, all other allergic diseases showed an increase ($p < 0.001$) from the second survey (Table 4 and Fig. 4). In the second survey, 31.6% of subjects were affected by at least one of AR, AD, AC, BA, or Pjc, while in the third survey, such subjects decreased to 34.1% (Fig. 5).

2) Older subjects tended to have AR, AC, and/or Pjc more frequently, with the exception of AD (Fig. 6).

3) The third survey revealed no major differences in the prevalence of the respective allergic diseases among urban, urban/rural, or rural areas (Fig. 7).

4) Allergic diseases except AD affected more boys than girls.

5) Urbanization and air pollution, but not pollen counts, had an effect on the prevalence of AR, AC, and Pjc. AD was not affected by these factors.

6) The use of cooling/heating system and ventilating fans were associated with a higher prevalence of all allergic diseases, while dirty-type heating was associated with a higher prevalence of allergic diseases with the exception of AD, and breast-feeding increased the prevalence of AR and AC (Table 4).

7) A past history of bronchitis, asthmatic bronchitis, or eczema was associated with a higher prevalence of all allergic diseases.

8) As indicated in Table 5, a family history of any allergic disease was associated with a higher prevalence of all allergic diseases ($p < 0.001$). In particular, subjects whose parent(s) had a history of AR were more frequently affected by AR and Pjc, and those with parent(s) having a history of eczema developed AD more frequently.

9) Logistic regression analyses were performed to

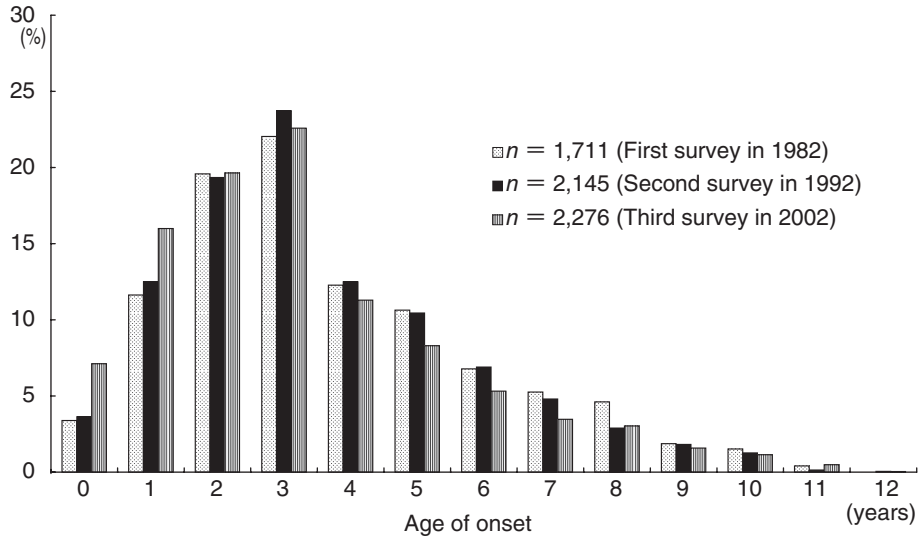

Fig. 3 Age of onset of bronchial asthma in asthmatics.

adjust the odds ratio for subjects with a present history of allergic diseases (BA, AR, AD, and AC) and those without a past or present history of these diseases. Results showed that past histories of sinusitis, bronchitis, asthmatic bronchitis, or eczema as a host factor were associated with a significantly higher odds ratio for all allergic diseases. Particularly high odds ratios were identified in relation to sinusitis (OR = 3.209) and asthmatic bronchitis (OR = 4.173) for AR, asthmatic bronchitis (OR = 3.284) and eczema (OR = 9.360) for AD, and asthmatic bronchitis (OR = 3.699) and eczema (OR = 3.005) for AC. The odds ratio for a family history (father or mother, or both) of allergic rhinitis and for eczema was also particularly high for AR (OR = 2.698) and AC (OR = 2.352), and for AD (OR = 2.735), respectively. Use of carpeting as an environmental factor was associated with a lower odds ratio for all allergic diseases, whereas NOx was associated with a higher odds ratio for all allergic diseases. Use of carpeting (OR = 0.722), maternal smoking (OR = 0.740), and population density (OR = 0.799) resulted in a lower odds ratio for AC.

DISCUSSION

Comparative studies between results of different epidemiological surveys generally present difficulties because of the non-identical conditions of the surveys: study sites, methodologies, and in particular, definition of BA used in studies on the prevalence of BA in the same samples. When using different definitions of the disease, the results showed prevalences ranging from 5.23% to 17.53%, showing a 3-fold or greater difference at maximum.[4] Surveys conducted in 7 regions in Japan around 1990 using the same ATS-DLD questionnaire as ours demonstrated the BA prevalence to be approximately 5%,[2] which was similar to our results. This fact supports the validity of the questionnaire.

The 3 epidemiological surveys presented here were conducted in subjects in the same age range and study sites using the same methodology, which was the most important characteristic of this series of surveys. In the first survey, the BA prevalence in the sixth graders only decreased to 80% of first graders. Furthermore, this downward trend was absent in the second and third surveys, indicating that the commonly-held opinion in Japan that childhood asthma would heal by the elementary school age is no longer true. All 3 surveys revealed that asthmatic attacks occurred in elementary school students without an upward trend, and this may represent a downward trend in the number of asthma students who no longer showed symptoms during the elementary school period. Analysis of the differences in the BA prevalence rate in different prefectures in western Japan revealed an 1.8-fold gap (2.26% to 3.97%) in the first survey, an 1.5-fold gap (3.45% to 5.20%) in the second survey, and an 1.7-fold gap (4.60% to 8.00%) in the third survey. The gap which could be observed between urban and rural areas decreased to a range of 6.2% to 6.5% in the third survey, showing no significant changes in environmental areas. There was also no difference in BA prevalence according to population density, which can be considered as a major change. The increased onset of BA in children at the age of 0 and 1 years was obvious in the third survey, consistent with the fact that many of the current inpatients with asthmatic attacks are infants. The boys-to-girls ratios in the 3 surveys were similar, 1.5, 1.6, and 1.6, respectively.

At the time of the first survey, the following factors were considered to contribute to the increase in individuals with bronchial asthma[1]: (1) worsening of air pollution; (2) decreased infant and child mortality; (3)

Table 7 Logistic regression analysis of risk factor for allergic diseases increased

		Bronchial asthma	*P* value	Allergic rhinitis	*P* value	Atopic dermatitis	*P* value	Allergic conjunctivitis	*P* value	Pollinosis	*P* value
Host factor	No	25738		30719		28359		26925		25478	
	sex	0.640	< .0001	0.647	< .0001	0.960	0.2576	0.778	< .0001	0.778	< .0001
	upper resp infection < 2y	1.198	0.0078	0.852	0.0005	1.004	0.9452	0.950	0.3636	0.927	0.2899
Past history	sinusitis	1.479	< .0001	3.221	< .0001	1.455	< .0001	1.911	< .0001	2.520	< .0001
	bronchitis	1.660	< .0001	1.605	< .0001	1.215	0.0001	1.704	< .0001	1.818	< .0001
	asthmatic bronchitis	37.850	< .0001	4.197	< .0001	3.302	< .0001	3.719	< .0001	3.345	< .0001
	eczema	2.545	< .0001	2.685	< .0001	9.358	< .0001	3.007	< .0001	2.587	< .0001
	otitis	0.795	0.0003	1.127	0.0002	0.761	< .0001	1.077	0.0795	1.071	0.1937
	tonsillitis	1.289	0.2491	1.445	0.0018	1.340	0.0550	1.498	0.0065	1.688	0.0021
History of parents	asthma	2.115	< .0001	1.161	0.0010	1.149	0.0111	1.111	0.0697	1.042	0.5671
	eczema	1.599	< .0001	1.484	< .0001	2.737	< .0001	1.619	< .0001	1.748	< .0001
	urticaria	0.977	0.7576	1.066	0.1191	1.180	0.0005	1.237	< .0001	1.038	0.5627
	allergic rhinitis	1.471	< .0001	2.716	< .0001	1.491	< .0001	2.368	< .0001	3.480	< .0001
Environmental factor	No	9388		11217		10456		9735		9280	
	nutrition	1.114	0.0370	1.059	0.0725	1.001	0.9862	1.044	0.3368	1.099	0.0890
	sibrings	0.952	0.2661	0.835	< .0001	0.958	0.1687	0.882	0.0015	0.805	< .0001
	father's smoking	0.998	0.9784	0.913	0.0230	0.990	0.8253	0.846	0.0031	0.786	0.0007
	mother's smoking	1.034	0.6746	0.858	0.0051	0.900	0.0787	0.740	0.0005	0.823	0.0494
	heater	1.265	0.0013	1.126	0.0097	1.032	0.5494	1.075	0.2576	1.161	0.0576
	number of rooms	0.876	0.0366	1.050	0.2190	1.027	0.5507	1.129	0.0279	1.071	0.3150
	cooler	0.839	0.2406	1.086	0.4179	1.030	0.7965	1.245	0.1451	1.505	0.0413
	bedroom	0.888	0.1238	0.905	0.0354	0.932	0.1906	0.903	0.1188	0.927	0.3521
	carpet	0.720	0.0003	0.814	0.0002	0.881	0.0363	0.723	< .0001	0.855	0.0949
	dog	0.819	0.0093	0.918	0.0526	0.925	0.1188	1.026	0.6537	1.068	0.3503
	bird	1.056	0.6560	0.996	0.9627	0.960	0.6575	0.808	0.0923	0.672	0.0268
	hamster	0.859	0.0190	0.967	0.3609	0.982	0.6613	0.846	0.0037	0.906	0.1462
	NOx (ppb)	1.024	0.7836	1.224	0.0002	1.173	0.0105	1.432	< .0001	1.544	< .0001
	number of pollen (/cm^2)	0.976	0.6879	0.979	0.5522	0.940	0.1376	0.814	< .0001	0.880	0.0355
	impacted	1.052	0.4578	0.945	0.2042	0.968	0.5075	0.800	0.0005	0.678	< .0001

*control: children without BA nor AR nor AD nor AC nor Pjc nor history of these diseases.

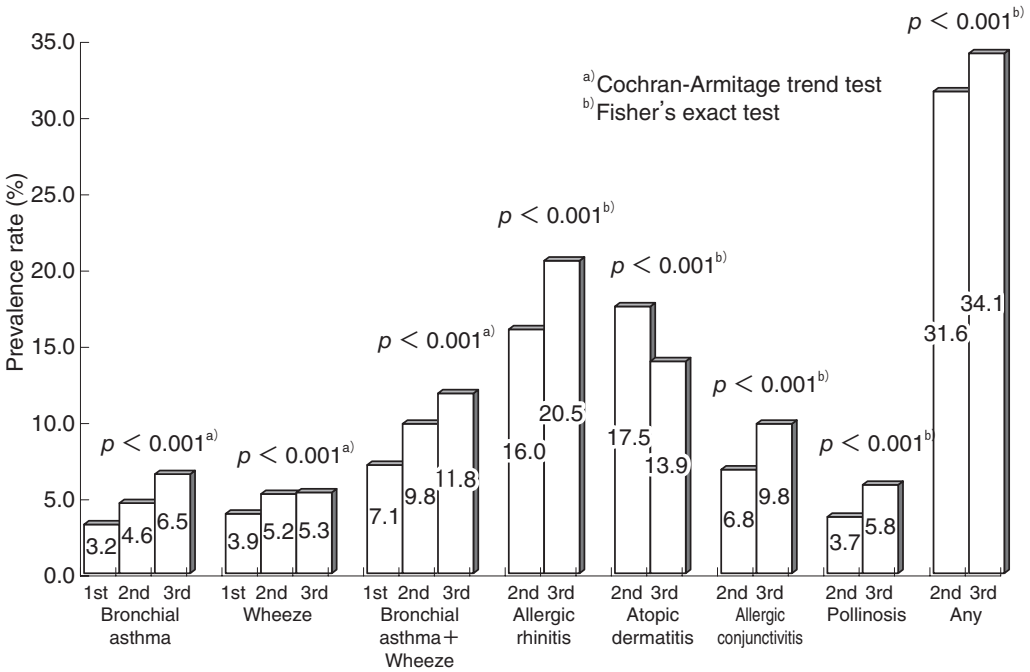

Fig. 4 Prevalence rate of allergic diseases in 1982, 1992 and 2002.

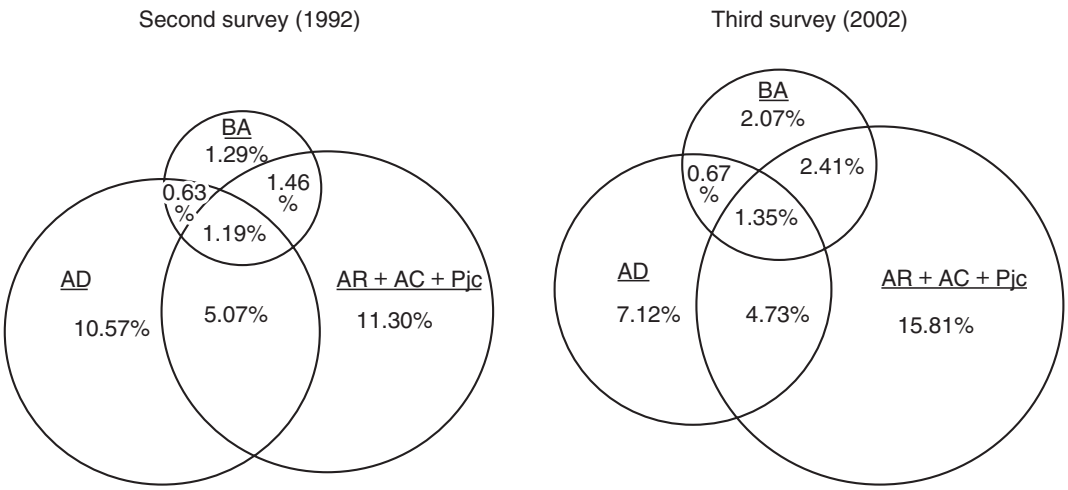

Fig. 5 Prevalence rate of three allergic diseases in second and third survey.
BA, bronchial asthma; AD, atopic dermatitis; AR + AC + Pjc, allergic rhinitis + allergic conjunctivitis + pollinosis.

changes in infection; (4) changes in eating habits; (5) changes in housing structure; (6) changes in psychological environments; and (7) increased individuals predisposed to allergy. In general, it can be said that most of these factors still remain as contributors to the increase in BA victims.

Major culprits regarding the problem of (1) above are NOx and SPM, both of which show no tendency to decrease. Among the elementary schools studied in the 3 surveys, 38, 37, and 38 schools had an ambient air measurement station within 2 kilometers for SO_2, NOx, and SPM, respectively. A significant correlation was identified only between the concentration of SPM and the prevalence of BA in the second survey ($p < 0.05$, $r = 0.50$). Although, one Japanese report states that NO_2-rich areas tend to have more children with asthmatic symptoms and areas with NO_2 >30 ppb are more likely to be associated with initial onsets of BA,[5] our research found no statistical significance in relation to the difference in NO_2 concentrations. A relationship between car exhaust emissions and Pjc has been reported,[6] although the relationship

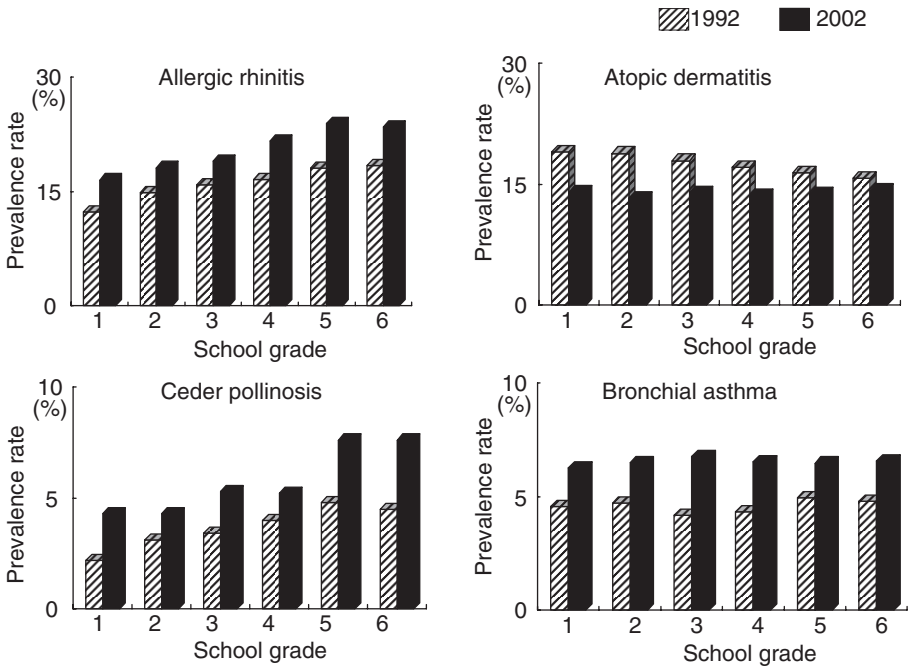

Fig. 6 Prevalence rate of allergic diseases in school grade in 1992 and 2002.

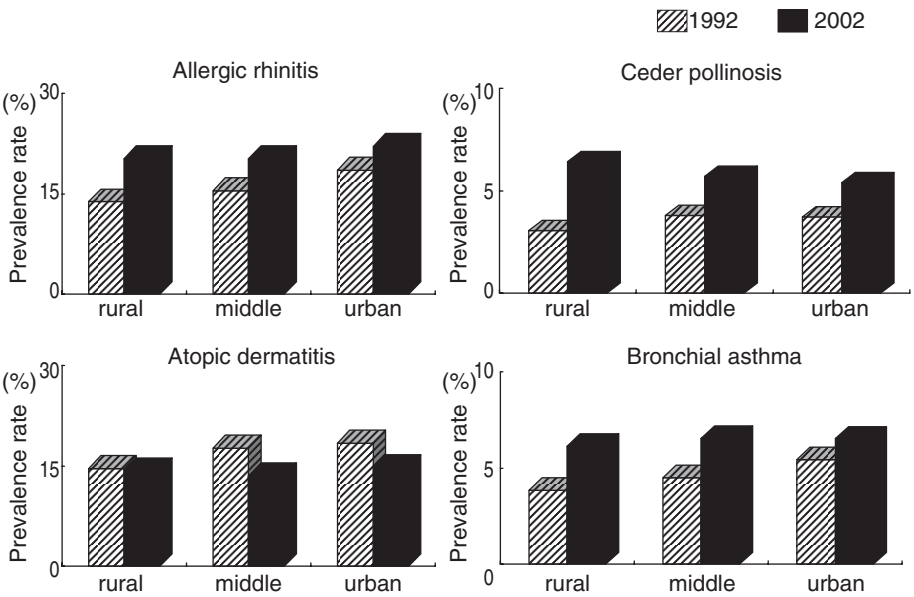

Fig. 7 Prevalence of allergic diseases among urban, middle, or rural areas in 1992 and 2002.

with BA remains unclear. The numbers of automobiles in Japan have been increasing at an accelerating rate. Based on the comparison of nationwide automobile driving distance figures in 1982 (403×10^9 kilometers), 1992 (678×10^9 kilometers), and 2002 (791×10^9 kilometers), the number of automobiles in 1992 was 1.7 times greater than that in 1982, and the number in 2002 was 1.2 times greater than that in 1992, and 2.0 times greater than that in 1982. An across-the-board increase in BA prevalence observed in all grades and regions in our surveys may suggest that we should focus more on auto emissions as an important air pollutant from a nationwide or even global perspective.

Concerning factors (2) and (3), a sharp decline in infections has chiefly resulted from decreased infant and child mortality due to the use of antibiotics, improved nutrition, improved hygienic environments,

and proliferation of healthcare knowledge. Since children with asthma are prone to airway infections, a decrease in mortality-related respiratory infections may have allowed clearer identification of airway allergies, revealing allergies that have previously been masked. In all 3 surveys, BA was prevalent 3- to 4-fold in subjects who answered "yes" to the question of "Have you ever experienced a severe cold or a major respiratory disease by the age of 2?" compared with the control subjects (Table 4). Considering that the age is under 2 and that the questions in the ATS-DLD questionnaire are very vague, the possibility cannot be denied that subjects who responded "yes" to the question regarding airway symptoms, may have had an asthmatic attack. Pneumonia-related mortality in early childhood (0–4 years, per 100,000 children) in 1980, 1990, and 2000 was 9.7, 4.0, and 2.8, respectively, showing a considerable reduction. However, the above considerations do not sufficiently explain the reason for the 2.1-fold rise in the BA prevalence in the past 20 years.

From the perspective of the controversial hygiene hypothesis,[7] subjects with more siblings tended to have odds ratio of less than 1 for all diseases in our surveys, and although its significance was identified for allergic rhinitis and conjunctivitis, it could not be identified for BA. The analysis of the relationship between indoor pets and the prevalence of allergic diseases revealed a significantly low probability for dogs, cats, and hamsters for BA, dogs and cats for AR, dogs for AD, cats and hamsters for AC, and cats and birds for Pjc. Although, these may be the results of improved environmental management, a reexamination from the viewpoint of hygiene hypothesis is needed.

One of the notable changes in dietary habits in children is a greater consumption of milk and eggs in early childhood, which may worsen allergies. A variety of food additives consumed should also be considered. When different feedings in infancy were compared, the BA prevalence increased in the order of non-breast feeding, mixed-feeding, and breast-feeding in the third survey. There is a highly reliable report showing no correlation between prenatal food consumption and postnatal IgE levels and the incidence of atopic diseases.[8] However, another report has demonstrated a wide gap in the prevalence of asthma according to different dietary habits in the same region.[9] There is a report indicating that approximately half of children under 2 years of age with a food allergy and AD develop asthma,[10] and another report states that the number of infants who started consuming eggs before 4 months of age increased from 26.6% to 66.7%, between 1975 and 1985, and soybeans and fish increased from 20.0% to 43.3% and 1.7% to 20.0%, respectively, in the same period.[11] With these findings, changes in dietary habits may be an important factor, however our 3 surveys produced no findings relevant to this issue, except for a significantly lower probability of prevalence in breast feeding for BA, AR, AD, and AC each in the third survey.

Regarding issue (5), a 2.7-fold increase in the average yearly income per capita in 20 years, with 1.11 million yen in 1975, 2.15 million yen in 1985, and 3.02 million yen in 1995, suggests that houses have become more air tight and better insulated in Japan. Income growth has; however, slowed since 1990 (2.84 million yen) as the growth rate from 1990 to 2000 (3 million yen) was only 6%. Increased air-tightness of houses is due mainly to wider use of aluminum-sash windows and air conditioning, which can cause problems, such as higher levels of indoor nitrogen oxides and adverse effects from indoor smoking. An analysis of BA prevalence according to the different types of heating systems revealed that BA prevalence was higher in the clean-type heating group in the first survey, whereas the dirty-type heating group had a higher prevalence in the second and third surveys. There was no difference in the BA prevalence between users and non-users of cooling/heating systems. Indoor smoking may have a greater impact on children when the house is air-tight. The results of the third survey showed that maternal smoking raised BA prevalence. Along with the proliferation of air-tight houses, more carpets have been used, space under the floor and the traditional custom of year-end general housecleaning have disappeared, and insecticides have been used less frequently, all of which collectively lead to an increase in indoor house dust mites. It is said that 400–2,000 mites are present in 1 g of house dust, and mites and mite-derived substances account for over 8% of the gross weight of house dust. According to the report by Furusho, the mean number of mites per carpeted room was 14,000–18,000 during July-October, a peak season for mites, and 2,000–3,000 even in the lowest season of January-April; and the number of mites present in a blanket ranged from approximately 33 to 14,000 (mean number: 2,300) and that in a *futon* was approximately 210,000.[12] Increases in these highly antigenic mites and mite-derived substances can be considered to have a greater effect on the sensitization of children today, who tend to spend more time indoors. Over 90% of students with BA, tested positive for an intradermal reaction to house dust, and our general field study revealed that 91% of BA students were classified as 4 based on the RAST score for *Dermatophagoides pteronyssinus* specific IgE.[13] A study by Carpin *et al.*, one of the major studies conducted outside Japan, demonstrated a clear difference in the rate of positive skin tests for mites between dry-winter mite-poor regions and other regions (10% and 45%, respectively).[14] In Papua New Guinea, the introduction of blankets was reported to result in a rise in the prevalence of adult BA from 0.1% to 7.3%.[15] The study also identified a difference in mite counts in

Table 8 ISAAC Study Phase I and III in Fukuoka, Japan[27]

	Prevalence (%)			
	Phase I (1995)		Phase III (2002)	
	6–7 y.o	13–14 y.o	6–7 y.o	13–14 y.o
Asthma symptom (severe asthma)	17.3 (1.8)	13.4 (2.1)	17.9 (1.7)	13 (1.5)
Allergic rhinitis (with allergic conjunctivitis)	25.6 (7.9)	41.0 (10.6)	32.8 (10.6)	45.7 (20.5)
Atopic eczema	21.3	13.5	20.0	14.4

blankets (1371 and 283 mites/g, respectively) as the only difference found between regions with a high prevalence of BA and similar regions with BA prevalence of as low as 0.3%. A study of the relationship between exposure to mites in infancy and the incidence of an allergy and the severity of sensitization to mites after 11 years revealed that longer exposure to mites was associated with a higher incidence of the allergy as well as severer sensitization to mites.[16] In contrast, our data demonstrated that using carpeting and having indoor pets associated with a lower prevalence of BA. Whether this is a result of successful education by medical staff of families with a BA patient regarding elimination of allergens or whether this suggests the correctness of the hygiene hypothesis remains unknown and requires further investigation.

Deterioration of psychological environments for children, a problem related to (6) above, may also be an important factor. Nowadays, the situation is worsening markedly. According to a 1995 survey on juvenile misdemeanors, the numbers of arrested motorcycle gang members, substance abusers, status offenders, girls with inappropriate sexual standards for juveniles, and runaway children, as well as the number of incidents of school violence or bullying in public elementary and middle schools were high. Compared to data from 10 and 20 years ago, the rate of absenteeism in elementary and middle schools increased 2.9- and 7.5-fold, respectively. Daily activities of modern elementary school students are characterized by a tight after-school schedule with studies after school hours, leisure activities, keeping late hours, less help with housework, and spending more time playing TV games and using the Internet.[17] Psychological factors are more or less involved in diseases. The role of such factors sometimes become greater as the disease progresses into a chronic condition.[18] The mother-child relationship has an important effect on the psychological environment of children, and a survey conducted in 1980 already identified a major trend that more mothers were less enthusiastic about child raising.[19] However, qualification and quantification of these psychological factors are difficult and whether they are closely associated with a 2.1-fold rise in the prevalence of BA in the last 20 years has yet to be clarified.

Analysis of predisposing factors for allergies disclosed that 31.8% of asthma patients had a relative with asthma within the second degree (except grandparents with asthma) and 61.8% had a family history of major allergies in the second survey. In the non-asthmatic group, the rates were 9.5% and 38.2%, respectively. In the third survey, the rates increased unanimously: 52.7% and 84.8% for the asthmatic group and 22.2% and 64.6% for the non-asthmatic group. These findings supported the increase in individuals predisposed to allergy.

Allergic diseases have recently been proliferating worldwide. Further insight into allergic pathologies and development of treatments has facilitated progress in treatment and management. However, evidence has yet to be seen for prevention of these diseases, improved cure rates, and decreased prevalence of the diseases. Identification of allergic factors has been the purpose for global epidemiological studies, but common definite factors have not been confirmed in Phase I, II, or III studies.

In the International Study of Asthma and Allergies in Childhood (ISSAC), asthma symptoms slightly increased on average in ISSAC Phase II (2002) over Phase I (1995) and regions with a low prevalence of those symptoms in Phase I had a higher prevalence in Phase II. In addition, English-speaking regions with a high prevalence in Phase I saw a decline in prevalence in the subsequent phase.[20-26] Fukuoka City in Japan participated in ISSAC, and the findings of the studies in this city showed that the prevalence of asthma symptoms in Phase I and III was 17.3% → 17.9% for the 6–7 year age group and 13.4% → 13.0% for the 13–14 year age group (Table 8).[27] The prevalence of asthma and atopic eczema therefore showed signs of decline or leveling off.

In Japan, as can be seen from the results of the 3 surveys, the prevalence of individual allergic diseases varies according to age, sex, and study period.

Conducting longitudinal epidemiological surveys on BA and related disorders in the same regions, and using the same methodology enables medical and administrative entities to examine new findings, establish the purposes for subsequent studies, and devise more accurate and appropriate administrative countermeasures. The most important challenge to the

present project is to continue the epidemiological study periodically and systematically. We are planning to conduct a fourth survey in 2012.

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